Appendix G

Fire Effects Modeling

Kenney Flats Fuels Treatment

Comparison of the effects of fuel treatments by alternative

The effects of wildfire can be determined by a number of fire behavior models available if certain variables are known. Inputs to the model include fuel loading, arrangement, and moisture content. Weather, such as wind speed and direction, temperature, and relative humidity, are important. Topography information including slope, aspect, and elevation are also important. The output from fire behavior models can be very accurate if the model is set up and calibrated by experienced fire managers.

The Farsite (Finney, 1998) fire growth simulation model was used to compare the expected changes in wildfire effects due to manipulation of the fuels in the 4 alternatives analyzed in the Kenney Flats Fuels Treatment Project. Farsite applies several well known fire behavior models to a complex environment using GIS technology. Some of the models applied by Farsite are surface fire model (Rothermel, 1972), crown fire (Van Wagner, 1977, 1993), and spotting from torching trees (Albini, 1979).

Fuels are represented across the landscape by pre-developed fuel models developed for the Behave fire behavior prediction and fuel modeling system (Rothermel 1984). Descriptions of each of the fuel models used can be found in the project file for this project. The various components of these fuel models are characterized by “time lag fuels”. For example a 1hour fuel is small, 0-¼” in diameter, and takes 1 hour to respond to changes in the moisture content of the surrounding air, 10 hour fuels are ¼”– 1” and take 10 hours to respond, 100 hour fuels are 1”-3” in diameter and take 100 hours to respond and so on. Live fuels Have 2 categories live herbaceous (grasses & forbs) and live woody (shrubs and trees).

The moisture content of each fuel type determines how quickly it will ignite and how fast it will burn.

$$\%\ \text{moisture} = \frac{\text{sample weight} - \text{dried sample weight}}{\text{dried sample weight}} \times 100$$

The model was set up, calibrated, and interpreted by David Dallison, a qualified Fire Behavior Analyst.

Since the timing and location of actual wildfires is difficult to predict 2 scenarios were developed, One which depicts fairly extreme conditions in terms of fuel moistures and weather similar to the conditions present during the Missionary Ridge Fire in 2002, and one which depicts fairly normal conditions. The model will then produce maps showing predicted size and intensity of a wildfire if it should occur under those conditions.

No suppression action was taken in these scenarios except it was assumed the highway would limit fire spread to the west. Fire suppression could take many forms from hand line construction, to use of aircraft, engines, and heavy equipment. The availability and time of arrival of resources changes constantly, it would be difficult to estimate the suppression response that would occur. In order to eliminate these additional variables in the analysis no suppression was modeled so fire effects could be compared on an equal basis.

In reality the fire would be quickly suppressed in the “normal” year since resources would be readily available and fire intensity low, resulting in fewer acres burned than depicted in this analysis. In the extreme scenario the acres burned in this analysis may be more accurate since suppression forces tend to utilize defensive tactics when fire conditions are severe or extreme.

Defensive tactics generally involve indirect attack of the fire, and structure protection. Rather than directly trying to extinguish the flaming front, the fire is allowed to spread until it reaches a fuel or topography break that will allow successful line construction and holding to stop further spread. Structures in the path of the fire are pre treated and protected by engines or pumps as the fire passes. Defensive tactics are generally successful in saving structures if they are defensible, but an increased number of acres burn since resources are used to protect structures.

Assumptions used:
All analysis was done 5 years after the project begins and assumes prescribed burning complete.

Extreme Scenario:
Fuel moistures
1HR 3%, 10HR 4%, 100 HR 7%, Live woody 100%, Live Herbaceous 100%.

Fire occurs August 14-16, fire starts AT 1300 8/14 and burns until 1600 8/16

No suppression action is taken except along highway 84 where fire spread to the west is halted

A 20 MPH eye level wind occurs from 1000-1200 and increases to 35mph from 1200-1400.

Normal Scenario:
Fuel moistures
1HR 8%, 10HR 12%, 100 HR 20%, Live woody 125%, Live Herbaceous 125%.

Fire occurs August 14-16, fire starts AT 1300 8/14 and burns until 1600 8/16

No suppression action is taken except along highway 84 where fire spread to the west is halted

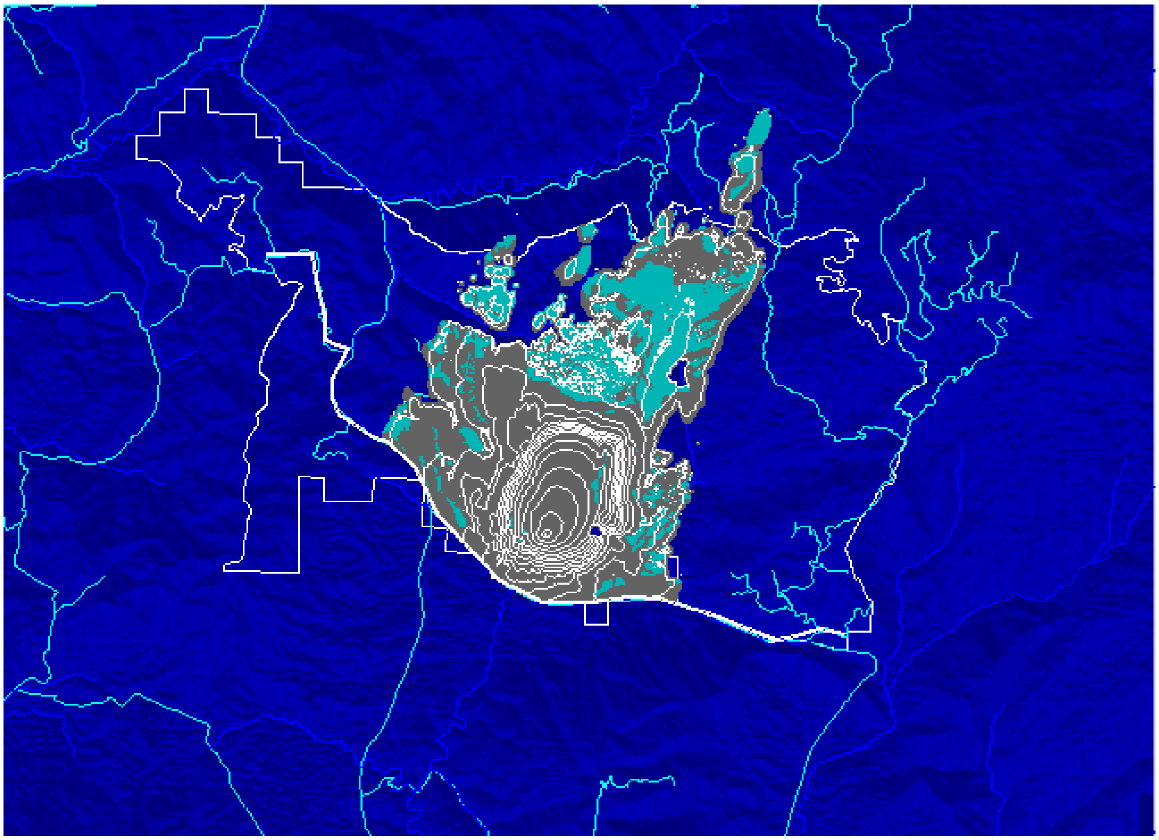
Winds are generally 4-8 mph with gusts to 15 mph.

The extreme scenario was run using current fuels conditions to simulate the no action alternative (Alt 1), then the fuel model map was edited within the proposed units to simulate the vegetative changes from harvesting and prescribed burning. All other parameters remained the same and the simulation was repeated to simulate fire effects following treatment (Alt 2,3&4).

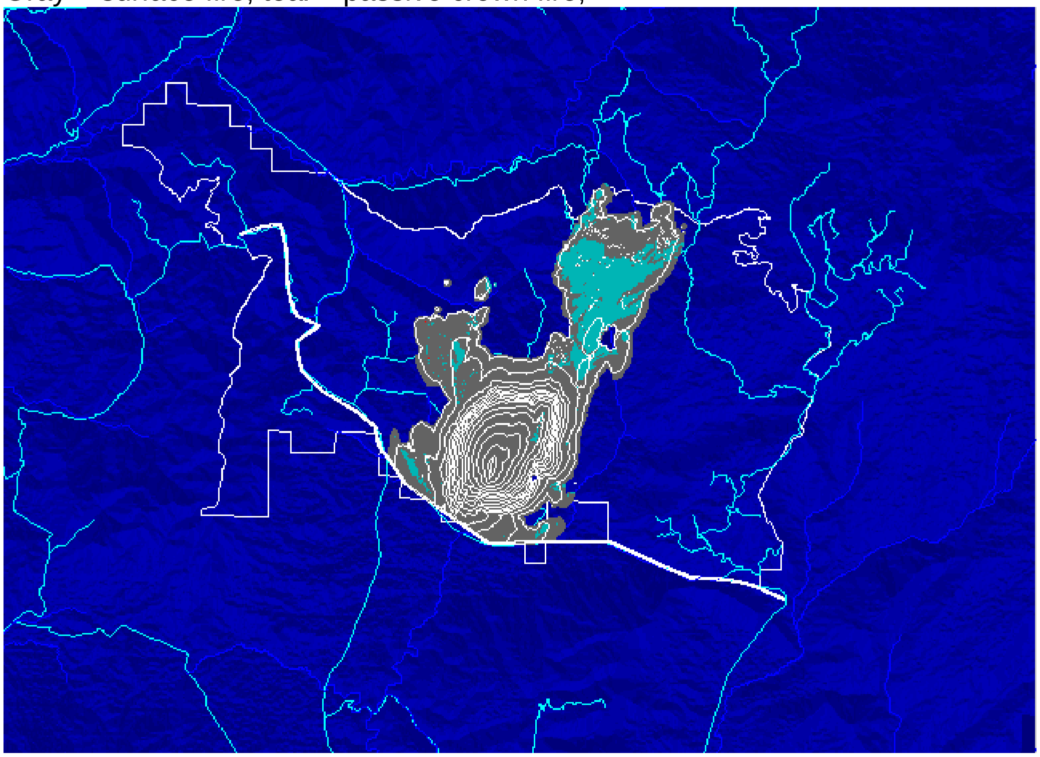
Fuel models were not changed, however the distance from the ground to the base of the tree crowns was increased from 3 feet to 9 feet to simulate the removal of the understory ladder fuels, and the crown cover % was reduced by 30-50% to approximate the density reduction in the overstory by logging.

The following are maps produced by the Farsite model for the extreme scenario with no treatment (Alternative 1) and following harvest and prescribed burning (Alternative 2, 3 and 4).

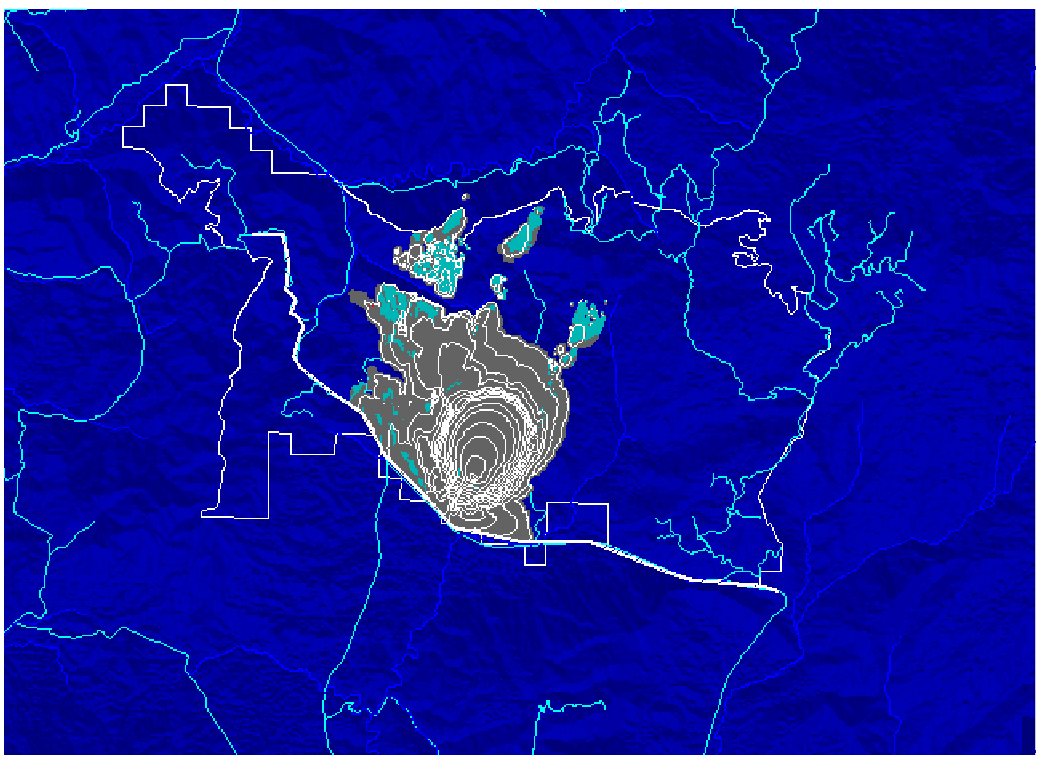
Alternative 1 No action, Extreme Scenario (current fuel conditions)
Gray = surface fire, teal = passive crown fire,



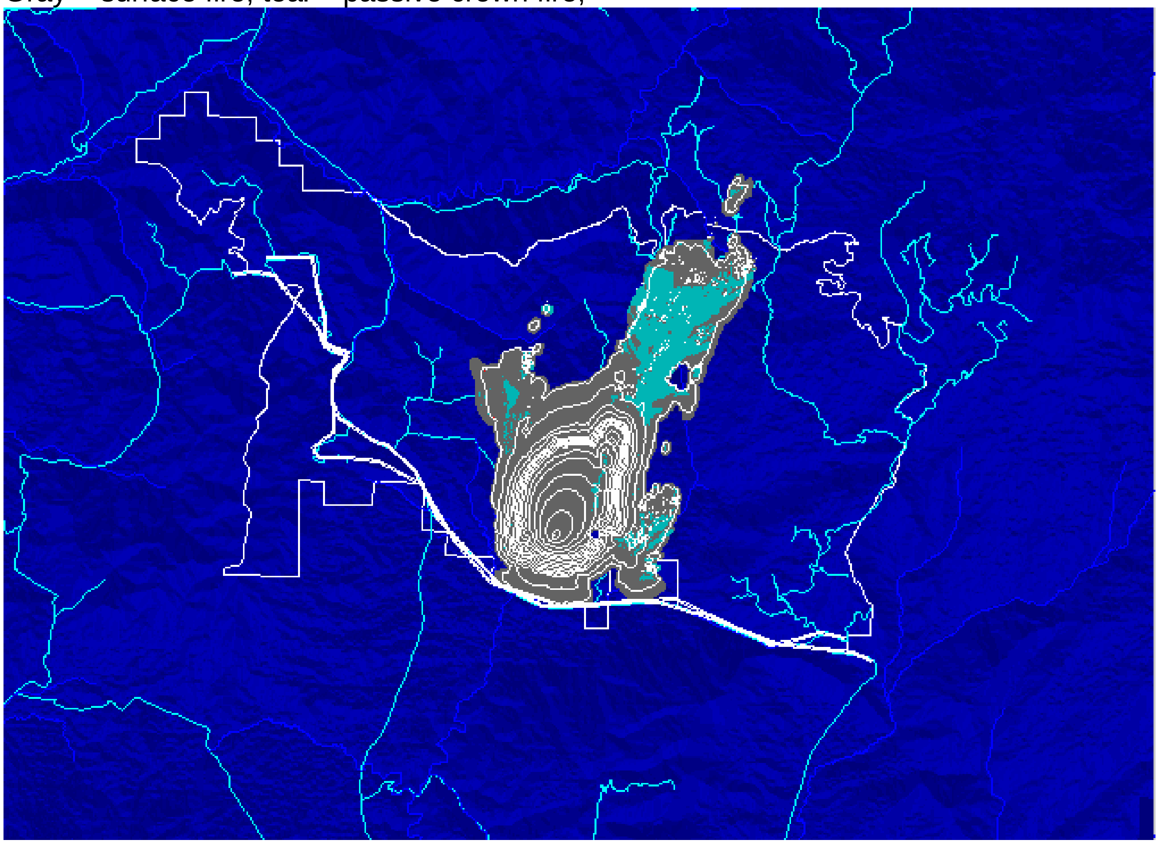
Alternative 2 , Extreme Scenario
Gray = surface fire, teal = passive crown fire,



Alternative 3, Extreme Scenario
Gray = surface fire, teal = passive crown fire,



Alternative 4, Extreme Scenario
Gray = surface fire, teal = passive crown fire,



Extreme scenario:

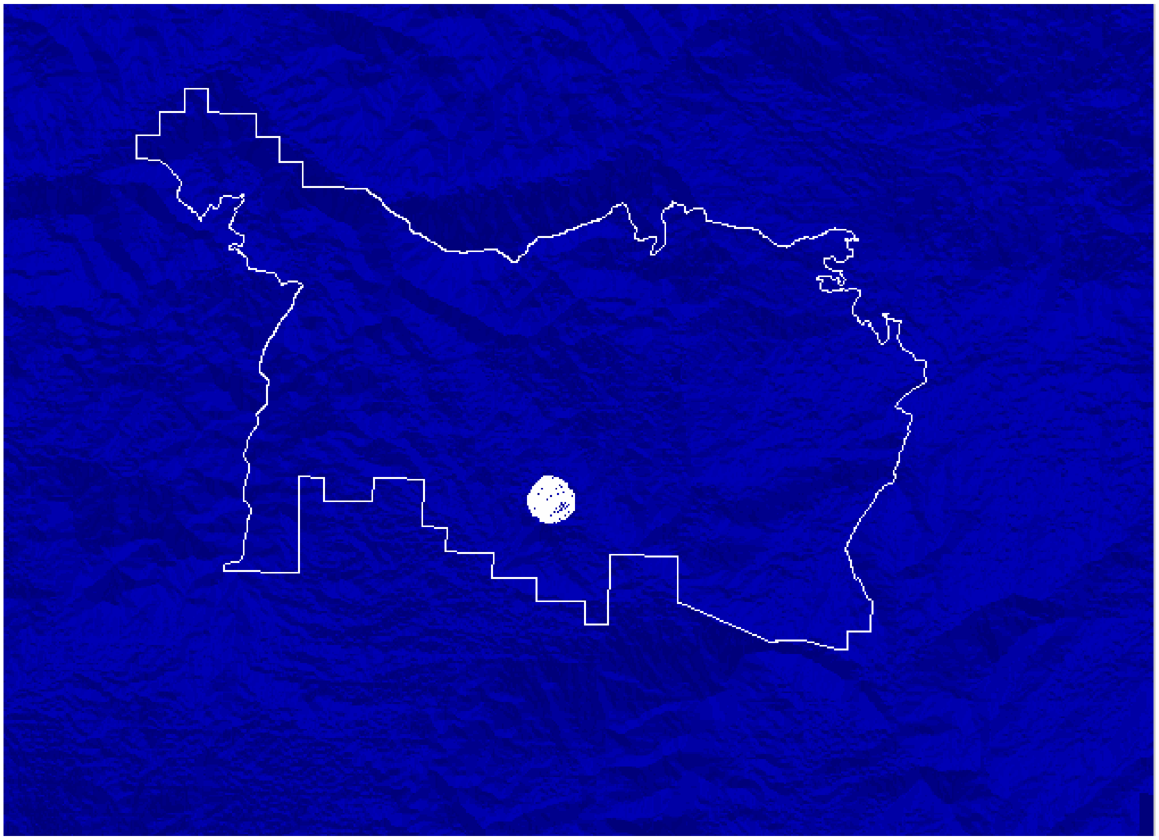
Alternative	Acres Crown Fire	Acres Surface Fire	Total acres burned
No Action	1,826 ac	3,709 ac	5,535 ac
Alt 2	637 ac	2,904 ac	3,541 ac
Alt 3	610 ac	2,780 ac	3,390 ac
Alt4	627 ac	2,674 ac	3,301 ac

Normal Scenario:
Then the whole process was repeated using the normal scenario.

The fuel moistures and weather used here were taken during the summer of 1998 when fires occurred but were generally of low intensity and seldom posed a threat to structures. Observed fire behavior was generally surface fire with some crowning and torching in the fuel types found in the Kenny Flats analysis area.

Under normal conditions fire spread is greatly reduced as shown by model outputs, as a result, the effects of the treatment much less evident. There was no significant difference in fire spread and there was no crown fire occurrence in any of the runs. Since all were similar only the no action run is presented as an example.

Alternative 1 No action, **Normal Scenario** (current fuel conditions)
Gray = surface fire.



Alternative	Acres Crown Fire	Acres Surface Fire	Total acres burned
No Action	0 ac	119 ac	119 ac
Alt 2	0 ac	119 ac	119 ac
Alt 3	0 ac	119 ac	119 ac

Conclusions:
Fire behavior is a very complex subject and has many variables, however the output from these models suggest that under severe to extreme fuel moisture and weather conditions, fewer acres will burn with lower intensity if the proposed treatments are implemented than if they are not. Many different ignition points and timing were tested, producing different outcomes but all point to a similar conclusion.

During extreme conditions fires in this fuel type spread in a number of ways, including; surface spread, crowning of individual and groups of trees, running crown fire, and spot fires started downwind by embers produced from the torching of tree crowns.

Treatments that increase the distance between the tree crowns and the ground (ladder fuels) will reduce the probability of a surface fire reaching the crowns (torching).

Treatments that increase the distance between individual tree crowns (density reduction) reduce the ability of the fire to move from crown to crown (running crown fire).

The treatments proposed in alternatives 2, 3 and 4 reduce both ladder fuels and density leaving surface spread the primary method of spread. Since torching and crowning is limited the production of embers and the associated spot fires are also minimized, the resulting fire behavior would be much more controllable by suppression forces.

The fire effects of alternative 2, 3 and 4 are very similar in this analysis since the changes in the fuel model would be similar and the particular scenario modeled did not spread far enough to impact the all of the units treated in alternative 2 and 4. Similar results could be expected if those units were to burn with reduced fire size and reduced acres of stand replacement fire. The primary difference in the alternatives is the number acres treated and the timing of that treatment.

Alternative Comparison:

Based on this analysis and experience, all of the action alternative would make a significant difference in the amount of crown fire that would occur with nearly a 66% reduction in crown fire. The result would be increased suppression success, and increased overstory survival which greatly reduces the long term effects of the fire on the forest.

The primary difference in the alternative would be risk due to the amount of slash on the ground at any one time, and the length of time that slash remains in place.

Alternative 2, treats all of the acres incrementally over time producing smaller amounts of slash, but does not remove the material. This creates a chronic slash problem over a wide area. Since the larger fuels are not removed, prescribed burning will be difficult to achieve since the window will be narrowed to spring only when large fuels retain winter moisture but fine fuels are drying out.

Alternative 3 completely treats a portion of the acreage completing the restoration work on the acres treated, removing large fuels as forest products. Removal of the forest products will reduce smoke production during prescribed burning, and will greatly widen the window when prescribed burning can be achieved. This alternative appears to be the easiest to implement from an operational point of view.

Alternative 4 treats all the acres in the first cycle and removes large fuels as forest products. The results would be similar to alternative 3 over a much larger area. Long term risk of stand replacement fire would be reduced the most by this alternative, however short term risk of fires occurring in logging slash prior to prescribed burning would be the highest with this alternative.

Summary:

Given these results, it is clear that during normal or less severe fire seasons the effects of the fuels treatments proposed by the Kenney Flats area would be small and suppression success would be high since fire intensity would be low and firefighting resources plentiful. In other words in a normal year firefighters would be able to put the fire out at a small size. During severe or extreme fire seasons the effects are much more pronounced and could make a 2 to 3-fold difference in acres burned, and acres of crown fire. The reduced fire intensity and rate of spread following treatment will also increase the effectiveness of more limited fire suppression forces, allowing direct attack rather than defensive strategies in the protection of structures, leaving a higher percentage of living overstory trees after the burn.

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